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Selfish nodes handling in replica allocation by clustering over MANET

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Abstract—A mobile ad hoc network (MANET) is a infrastructure-less network with self configuring capability of mobile nodes connected by wireless. Each node moves freely in any direction, and will therefore change its links to other devices frequently. Since mobile hosts move freely, disconnections occur frequently and this causes frequent network division. So, the data sharing in network play a vital role. For effective data sharing, the data replication is needed. Many data replication techniques have been proposed to minimize performance degradation. In most cases it is assumed that all mobile nodes collaborate fully in terms of sharing their memory space. Some nodes decide not to cooperate. Performance of the network and data accessibility is affected by these selfish nodes. The proposed work examines the impact of selfish nodes in a mobile ad hoc network from the perspective of replica allocation. It is termed as selfish replica allocation. The work includes developing a selfish node detection algorithm that considers a replica allocation technique for effective selfish replica allocation.

Index Terms — accessibility, availability, MANET, partition, replica allocation, selfish nodes, and topology.

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1 INTRODUCTION

A MANET is a type of ad hoc network that can change locations and configure itself, Because MANETS are mobile, and they use wireless connections to connect to various networks. Some MANETs are restricted to a local area of wireless devices (such as a group of laptop computers). An ad hoc network typically refers to any set of networks where all devices have equal status on a network and are free to associate with any other ad hoc network device in link range. Ad hoc network often refers to a mode of operation of IEEE 802.11 wireless networks.

Each must forward traffic unrelated to its own use, and therefore be a router. The primary challenge in building a MANET is equipping each device to continuously maintain the information required to properly route traffic. Such networks may operate by themselves or may be connected to the larger Internet. MANETs are a kind of Wireless ad hoc network that usually has a routable networking environment on top of a Link Layer ad hoc network. Different types of MANETs include,

- InVANET – Intelligent vehicular ad hoc networks make use of artificial intelligence to tackle unexpected situations like vehicle collision and accidents.
- Vehicular ad hoc network (VANET) – Enables effective communication with another vehicle or helps to communicate with roadside equipments.
- Internet Based Mobile Ad hoc Network (iMANET) – helps to link fixed as well as mobile nodes.

Quick configuration and easy deployment make ad hoc networks suitable for emergency situations like natural disasters, military conflicts, emergency situations etc.

1.1 Data Replication

In ad hoc networks, since mobile hosts move freely, disconnections occur frequently, and this causes frequent network partition. If a network is partitioned into two networks due to the migrations of mobile hosts, mobile hosts in one of the partitions cannot access data items held by mobile hosts in the other. Thus, data accessibility in adhoc networks is lower than that in conventional fixed networks. In ad hoc networks, it is very important to prevent the deterioration of data accessibility at the point of network partition. A possible and promising solution is the replication of data items at mobile hosts which are not the owners of the original data. Since mobile hosts generally have poor resources, it is usually impossible for them to have replicas of all data items in the network.

1.2 Selfishness in MANET

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In general, if mobile nodes in a MANET have sufficient memory space to hold the replicas of all data items, then data replication can simultaneously increase data accessibility and reduce query delay. However, since most mobile nodes have limited memory space for replicas of data items, there is often a trade-off between data accessibility and query delay.

This trade-off may lead to the selfish behavior of mobile nodes in a MANET. A node would like to use resources provided by other nodes, but it may not give a support by providing its own resource available to help others. Such nodes are termed as selfish node and this behavior can potentially lead to a wide range of problems for a MANET.

1.3 Clustering

The task of finding and maintaining routes in an adhoc network is non-trivial since host mobility causes frequent unpredictable topological changes. In highly mobile situation, the flooding scheme is the most reliable for sending data packets. However, since the link channel and battery power resources are very scarce, more efficient schemes must be devised. These schemes require up to date information about the location of nodes. Storage is not a critical issue since memory continues to get less expensive each year. The savings in communication bandwidth and energy come from reporting only to nodes that need particular information. To reduce the transmission overhead for the update of routing tables after topological changes, it was proposed to divide all nodes into clusters. The overhead of cluster formation and maintenance cannot be ignored. In the general cluster-based schemes for ad-hoc networks, clusters are formed at first, and one cluster head (CH) is elected for each cluster, in the fully distributed fashion.

In cluster based approaches [GT, KHC, KK, L1, RBS, S, TRTN], the sender must know the location information of the cluster within which the destination is located. Routing algorithm may consist of routing from source to its CH, from the CH to the CH of destination node, and from the later node to the destination. Communication between CHs involves intermediate nodes in their clusters. To reduce the power consumption in CH nodes, the information about all CHs may be replicated in all the nodes of the network. Each node knows the content (i.e. the list of nodes) only for its own cluster. The sender may forward the directly towards destination's CH, and does not need to 'consult' its CH. Moreover, the routing paths do not necessarily have to pass through any of the CH's, since the message can be rerouted toward the next cluster as soon as it enters any of the clusters.

2 RELATED WORK

Takahiro Hara (2001) [6] proposed three replica allocation techniques to improve data accessibility by replicating data items on mobile hosts. In these three methods, the author has considered the access frequency from mobile hosts to each data item and the network connection's status. In SAF (Static Access Frequency) method, the parameter such as access frequency to each data item is taken into account. In DAFN (Dynamic Access Frequency and Neighborhood) method, each data item's access frequency and the neighborhood among mobile hosts are taken into account. In DCG (Dynamic Connectivity based Grouping) method, each data item's access frequency and the whole network topology are taken into account.

Guohong Cao, Liangzhong Yin and Chita R.Das (2004) [2] proposed a co-operative cache based data access framework for caching the data or the path to the node to reduce query delays and improve data accessibility. A hybrid cache provides a better performance in controlling overhead in network due to caching. This method uses time-to-live mechanism to maintain cache consistency. For secure co-operative caching, different levels of security for each data item are provided.

Kashyap Balakrishnan, Jing Deng and Pramod K. Varshney (2005) [1] proposed a two network- layer acknowledgement- based schemes namely, the TWOACK and the S-TWOACK schemes that are added to any source routing protocol. The TWOACK scheme identifies the misbehaving nodes and try to avoid the misbehavior by notifying the source routing protocol to avoid them in future routing. S-TWOACK (Selective-TWOACK) is to reduce the extra traffic created by TWOACK.

Takahiro Hara and Sanjay K. Madria (2009) [7] classified consistency levels according to applications' demand and have designed protocols to achieve them, since in MANETs, peers' disconnection causes frequent network partitions, it is toiling and in some cases, not desirable to provide conventional strong consistency of data operations. Classified consistency levels as global, local, time-based, peer-based and application-based consistency and proposed different protocols to achieve these consistency levels.

Takahiro Hara and Sanjay K. Madria (2006) [5] improved the replica allocation techniques by considering non-periodic updates and integrating user profiles consisting of mobile users' schedules, access behavior, and read/write patterns. By using the Read/Write Ratio (RWR), the extended methods can handle data updates at each mobile host. We allow

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emergency objects to be unconditionally replicated. This is targeting safety and time-critical application domains.

3 PROBLEM STATEMENT

Selfish nodes may not transmit data to others to conserve their own batteries. Although network issues are important in a MANET, replica allocation is also crucial, since the ultimate goal of using a MANET is to make resources available to all users who are requesting service. Response may be failed not only due to selfish nodes but also due to network partition. Routing may be done by avoiding selfish nodes in the path and distance is also considered by avoiding distant nodes in order to overcome network partition to some extent.

4 PROPOSED SYSTEM

- Designing a central server
- Monitoring nodes
- Detecting selfishness
- Replica allocation

4.1 Designing a Central Server

Nodes are grouped into clusters. One hop neighbor nodes are grouped into clusters so that the node with higher memory becomes the cluster head. The disadvantage in existing system can be rectified by designing a central server by effectively replicating data in spite of network partition. Through clustering and replica using clustering may decrease impacts of network partition. Central server is also used to monitor nodes for its selfishness behavior.

4.2 Monitoring Nodes

Monitoring nodes includes sending queries to the neighbor nodes or cluster members and the selfishness is calculated based on number of responses. Credit risk score value is calculated for each cluster member with number of responses.

4.3 Detecting Selfishness

The nodes are monitored by central server and the credit risk score is updated after every transmission. The selfish node is detected based on credit risk score. The selfish node should be avoided during the course of routing in order to improve the throughput and reduce loss of data.

$$nCR_i^{\,k} = \frac{P_i^{\,k}}{\left[\left(\frac{ND_i^{\,k}}{n_i}\right)\right]} \qquad (1)$$

$nCR_i^{\,k}$ = normalized credit risk value
$P_i^{\,k}$ = ratio of N_i request not served
$ND_i^{\,k}$ = no. of data items shared between i & k
n_i = no. of data items accessed by node i

Pseudo code to detect selfish nodes

At every relocation period

/*Ni detects selfish nodes with this algorithm */

detection(){

for (each connected node N_k){

if ($nCR_i^{\,k} < \delta$) N_k is marked as non-selfish;

else N_k is marked as selfish;}

wait until replica allocation is done;

for (each connected node N_k){

if (N_i has allocated replica to N_k){

$ND_i^{\,k}$ = the number of allocated replica;}

else{

$ND_i^{\,k} = 1$;

} } }

4.4 Replica Allocation

Replica allocation is done by avoiding the selfish nodes along the path of source and destination. Central server is helpful here which maintains the details of selfish nodes. The node requesting for replication in another node communicates with that node through cluster head. Cluster head communicates with the cluster head which has the destination as its cluster member.

Pseudo code for replica allocation

/*N_i executes this algorithm at relocation period */

replica_allocation(){

for (each data item $\in D_i$){

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if (M_s is not full)

allocate replica of the data to M_s ;

else{/*M_s is full */

allocate replica of the data to the target node;

/*the target node is selected from L_i*/

if (M_p is not full)

allocate replica of the data to M_p; } }

while (during a relocation period){
if (N_k requests for the allocation of D_q)
replica_allocation_for_others (N_k, D_q); } }

The cluster member is checked with its selfishness and data are replicated or else the node which is not selfish is chosen for replicating by the central server.

5 SIMULATION RESULTS

5.1 Throughput

Throughput is usually measured in bits per second (bit/s or bps), and sometimes in data packets per second or data packets per time slot. It is the measure of no. of packets received during an interval of time. It increases with increase in no. of nodes. It increases due to increase in no. of forwarders of packets for successful transmission as in fig 1.

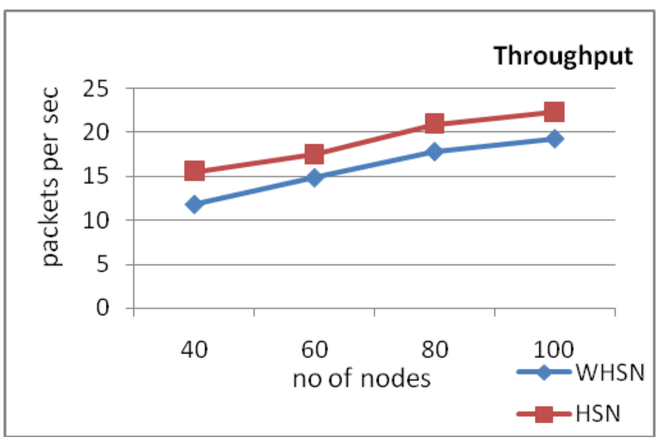

Fig -1: Throughput

5.2 Overhead

Overhead is the amount of traffic in the network. It increases with the increase of nodes. It is increasing, due to the amount of packets transmission increases in the network as in fig 2.

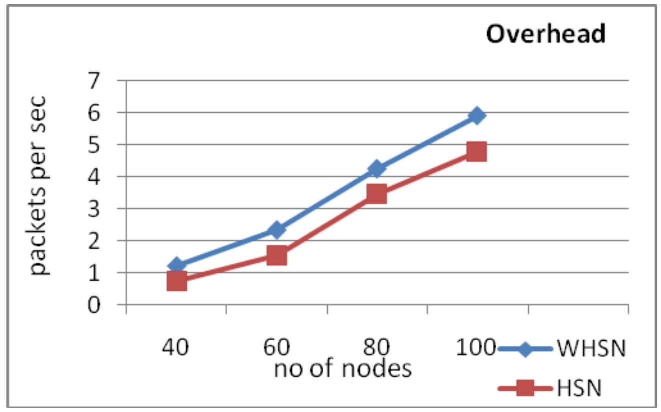

Fig -2: Overhead

5.3 Packet Delivery Ratio

Packet Delivery Ratio is measured by no. of packets received divided by no. of packets actually sent. It decreases with increase in no. of nodes. It decreases due to no. of nodes increase with increase in no. of intermediate nodes for successful transmission of packets as in fig 3.

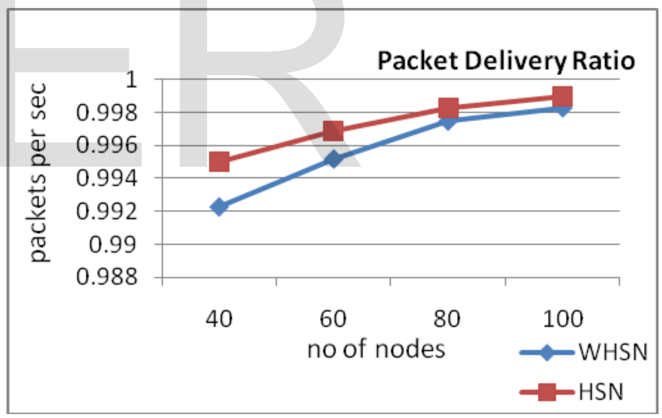

Fig -3: Packet Delivery Ratio

Clustering ensure that the network details of nodes are maintained in the central server and it also helps in allocating replica to right node, thus increases the performance and reduces the packet loss.

6 CONCLUSION

The replica allocation is carried out effectively by handling selfish nodes in the network. This was motivated by the fact that a selfish replica allocation could lead to overall poor data accessibility in a MANET. The proposed work includes a selfish node detection method using selfish behavior of the nodes

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and network partition. This technique helps to identify effective route excluding selfish nodes and reduce false alarm to some extent. This enables the overall availability and accessibility of the resources in the mobility environment. Impact of data updates and different moving patterns may be considered for future work.

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